

ACRYLONITRILE
CAS No. 107-13-1

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CARCINOGENICITY

Acrylonitrile is *reasonably anticipated to be a human carcinogen* based on sufficient evidence of carcinogenicity in experimental animals (IARC V.19, 1979; IARC S.4, 1982; IARC S.7, 1987; ATSDR, 1990-R004). When administered orally (by gavage or in drinking water), acrylonitrile induced increased incidences of forestomach squamous cell papillomas, central nervous system microgliomas, mammary gland carcinomas, and Zymbal gland carcinomas in rats of both sexes. Inhalation of acrylonitrile induced Zymbal gland carcinomas, forestomach papillomas and acanthomas, and central nervous system neoplasms in rats of both sexes.

There is limited evidence for the carcinogenicity of acrylonitrile in humans (IARC V.19, 1979; IARC S.4, 1982; IARC S.7, 1987). An epidemiological study of textile-plant workers potentially exposed to acrylonitrile and observed for 20 years or more showed an increased incidence of cancers of the lung; further follow-up of this cohort revealed a continued excess of lung cancer, although during the actual 5-year follow-up period there was no excess. The follow-up also showed a significant excess of cancer of the prostate. In a similar study at another textile-fiber plant, an excess of prostatic cancer was observed, but there was no excess of lung cancer. Another occupational study of persons potentially exposed to acrylonitrile and followed for 10 years or more indicated an increased incidence of cancers of the stomach, colon, brain, and respiratory tract (IARC V.19, 1979). Among rubber workers exposed to acrylonitrile, excesses were noted for cancers of the lung and of the lymphatic and hematopoietic systems. Another study of rubber workers however, showed no association between exposure to acrylonitrile and lung cancer. One study of workers exposed to acrylonitrile in 12 different plants showed excesses of bronchial cancer and of tumors of the lymphatic system.

PROPERTIES

Acrylonitrile is a colorless, volatile liquid that is soluble in water and most common organic solvents such as acetone, benzene, carbon tetrachloride, ethyl acetate, and toluene. It melts at -84 °C and boils at 77 °C. Technical-grade acrylonitrile is more than 99% pure. The technical-grade product always contains a polymerization inhibitor. Acrylonitrile is a reactive chemical that polymerizes spontaneously and can explode when exposed to flame.

USE

Acrylonitrile is an important industrial chemical. It is used extensively in the manufacture of synthetic fibers, resins, plastics, elastomers, and rubber for a variety of consumer goods such as textiles, dinnerware, food containers, toys, luggage, automotive parts, small appliances, and telephones (SRIC, 1984). In 1986, about 40% of the acrylonitrile produced was used to produce acrylic and modacrylic fibers, 28% to produce acrylonitrile-butadiene-styrene (ABS) and styrene-acrylonitrile (SAN) resins, and 15% to produce adiponitrile, an intermediate used in nylon production. The remainder was used in the production of acrylamide (10%), nitrile elastomers,

barrier resins, and miscellaneous specialty chemicals (4%) (Chem. Profile, 1986a). Acrylonitrile has also been used as a fumigant; however, most pesticide registrations of the chemical were canceled in 1978, and its use as a fumigant has been abandoned (ATSDR, 1990-R004).

PRODUCTION

Acrylonitrile has been produced in the United States since 1940 (IARC V.19, 1979). It has been ranked in the top 50 highest-volume chemicals by *Chemical and Engineering News* for the past several years. US production of acrylonitrile averaged 2.7 billion lb for the time period 1985 to 1987 (Chem. Eng. News, 1996-1998).

Imports of acrylonitrile, which have substantially decreased since the 1970s, are considered negligible and have been since 1984 (ATSDR, 1990-R004). For example, in 1985 only 441 lb were imported into the United States (USDOC Imports, 1986). In 1989, an increase was seen with the reported value greater than 400,000 lb (USDOC Imports, 1990). In contrast, a sizable fraction of acrylonitrile is exported (ATSDR, 1990-R004). In 1989, over 942 million lb were exported (USDOC Exports, 1990). This figure is similar to the 944 million lb reported for 1986 and the 943 million lb reported for 1985 (Chem. Week, 1987a; USDOC Exports, 1986). In 1984, the value was 834 million lb (Chem. Prod., 1985a).

EXPOSURE

The primary routes of potential human exposure to acrylonitrile are inhalation and dermal contact. Exposure to acrylonitrile may occur during its manufacture and production; greater potential for exposure exists for workers using acrylonitrile to make other products in factories where the compound is not easily contained (DPIM, 1989). The National Occupational Exposure Survey (1981-1983) indicated that 51,153 total workers, including 25,320 women, were potentially exposed to acrylonitrile (NIOSH, 1984). The National Occupational Hazard Survey, conducted by NIOSH from 1972 to 1974, estimated that 71,610 workers were potentially exposed to acrylonitrile in the workplace (NIOSH, 1976). In a later report, NIOSH estimated that 125,000 persons have the potential for occupational exposure (NIOSHb, 1978). These may be overestimates because nonexposed workers within each Standard Industrial Classification may not have been excluded. Based on industrial sources, a more reasonable estimate of the number of workers exposed is 5,130 people (NCI DCE, 1985a). These individuals include acrylic resin makers, synthetic organic chemists, pesticide workers, and rubber, synthetic fiber, and textile makers.

People living near chemical factories or waste sites are the likely candidates for exposure to measurable amounts of acrylonitrile in air and water. The remaining general population may be potentially exposed through consumer product usage such as acrylic carpeting or by ingestion of contaminated foods. Exposure in each case, however, is very low because of little migration of the monomer from such products (ATSDR, 1990-R004). The concentrations of acrylonitrile in consumer products are estimated to be less than 1 ppm in acrylic and modacrylic fibers, 30 to 50 ppm in ABS copolymers, 15 ppm in SAN copolymers, and 0 to 750 ppm in nitrile rubber and latex goods (Patrianakos and Hoffman, 1979). In the 1960s and 1970s, acrylonitrile was also detected in cigarette smoke, usually at levels of 1 to 2 mg per cigarette, since the chemical was used as a fumigant for stored tobacco. It is unlikely that cigarette smoking is today a major source of exposure to acrylonitrile; its use as a fumigant has been discontinued (ATSDR, 1990-R004). The presence of acrylonitrile, even as a trace contaminant, may be cause for concern. The extent or risk

of any potential exposure for the general population through air emissions from production, manufacture, bulk storage, and waste disposal has not been determined. A 1977 report stated that total acrylonitrile air emissions were 2.2% of total production. The Toxic Chemical Release Inventory (EPA) estimated that 4,891,577 lb of acrylonitrile were released to the environment from 97 facilities that produced, processed, or used the chemical in the United States in 1996. Of that total, 26.5% was released to the air and 73.5% to underground injection wells. Air emissions from 17 facilities, each releasing > 10,000 lb, represented 92.7% of the total atmospheric release. Six facilities, each releasing > 100,000 lb, accounted for 98.2% of the total underground injection release. Releases to water and land were very low—590 lb and 302 lb, respectively (TRI96, 1998). Based on a time-weighted average (TWA), ACGIH (1996) recommended a threshold limit value of 2 ppm (4.2 mg/m³) for acrylonitrile.

REGULATIONS

In 1980 CPSC preliminarily determined that acrylonitrile was not present in consumer products under its jurisdiction. Subsequently, public comment was solicited to verify the accuracy of this information; no comments were received. Pending receipt of new information, CPSC plans no action on this chemical. EPA regulates acrylonitrile under the Clean Air Act (CAA), Clean Water Act (CWA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), Resource Conservation and Recovery Act (RCRA), and Superfund Amendments and Reauthorization Act (SARA). Exposure and technology assessments were completed in 1985 under CAA. In 1978, EPA declared acrylonitrile a hazardous substance, based on its reported acute toxic effects. As a result, EPA promulgated hazardous spill regulations under CWA, establishing a reportable quantity (RQ) of 100 lb, and proposed to reduce the RQ to 10 lb under CERCLA. The final rule RQ under CERCLA is 100 lb. Acrylonitrile was classified for restricted use as a pesticide under FIFRA, which led to the voluntary cancellation of its product registration by the producer before an RPAR process was initiated. EPA's Carcinogen Assessment Group included acrylonitrile on its list of potential carcinogens. Under RCRA, acrylonitrile has been designated a hazardous constituent of waste. Under SARA, EPA established reporting requirements and general threshold amounts for acrylonitrile; the threshold planning quantity (TPQ) for acrylonitrile is 10,000 lb. Although this chemical does not meet EPA's toxicity criteria, following consideration of its high production volume and recognized toxicity, EPA found acrylonitrile to be a chemical of concern ("Other Chemicals"). FDA has banned the use of acrylonitrile copolymers for beverage containers and proposed to limit migration of acrylonitrile from other food-contact materials to 50 ppb. FDA was asked to review the ban. FDA reviewed all acrylonitrile regulations to align them with current carcinogenicity data. The review included an advisory opinion and a subsequent proposal for use of a new type of container that limits migration of acrylonitrile. FDA has set specific restrictions on use and migration of acrylonitrile for food containers and food contact surfaces. NIOSH has recommended TWA exposure limits for acrylonitrile be set at 1 ppm and a short-term ceiling value be set at 10 ppm (NIOSHc, 1994). OSHA enacted regulations to reduce worker exposure by establishing a permissible exposure limit (PEL) of 2 ppm (4.5 mg/m³) as an 8-hr TWA with no eye or skin contact. This standard requires personal protective equipment, training, medical surveillance, signs and labeling, and engineering controls. OSHA regulates acrylonitrile as a chemical hazard in laboratories under the Hazard Communication Standard. Regulations are summarized in Volume II, Table B-4.